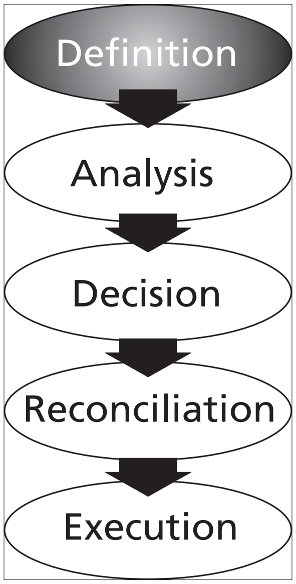
CHAPTER 2

PROBLEM DEFINITION



"Difficulties" is the name given to things it is our business to overcome.
-E.J. King: Address to the graduating class of the U.S. Naval Academy, 19 June 1942

A CLEAR PROBLEM DEFINITION IS THE FIRST, and, perhaps, most important step toward rationally selecting the best alternative. Many dedicated and intelligent individuals have produced elegant solutions for problems other than those they were tasked to solve. Therefore, a good executive decision maker participates in problem definition because this step establishes the goal for everything else that follows and places a premium on professional judgment.

In this chapter, we will discuss the opening phase of our Executive Decision-Making Framework: we will examine techniques to describe defense problems in terms that are meaningful to our organization and our decision maker, examine those problems' contexts and boundaries, and then prepare for the Analysis Phase by specifying its objectives. The components of the Definition Phase are shown in figure 2-1 on the next page; we will explain each element in turn and apply them to an example case at the end of the chapter.

The Decision Maker

One of the first areas we must address in the Definition Phase is who we will identify as our decision maker—our approval authority—for the problem we are going to solve now. In the Department of Defense (DoD), there are many decision makers between, on one hand, the development of a concept and, on the other, equipment procurement or policy execution. Beyond the Pentagon, there are more decision makers in the Executive Branch of the Federal Government who evaluate DoD proposals and forward them (sometimes with modifications) in the President's Budget Request to Congress. Within Congress, there are hundreds of individual decision makers. It is they who fund these DoD-originated proposals—sometimes with their own alterations. Moreover, Congress's decisions may not be permanent from one budget to the next, since even funding for multi-year programs, the most stringent type of government budgeting, can be revised or rescinded. Thus, even at the highest level of government, there is no single, final decision maker.

As senior leaders in DoD, whether officer or civilian, we have a chain of command that provides both a forum and a path for our decision making. It also helps us determine who we will identify (beyond ourselves) as the immediate decision maker and the approval authority for our problem solving efforts. In this course, we will generally take the perspective that we are assigned to a joint staff, service staff, or to the Office of the Secretary of Defense. Our immediate superior tends to participate directly in the work that leads to our decision, whether we are selecting an alternative to promote further up the chain of command or evaluating proposals by others. Occasionally, we may target him or her as the decision maker in terms of our framework, but usually the decision maker we identify is senior to our immediate superior and outside our daily workings. We will therefore assume while using our framework that the decision maker is the first General or Flag Officer in our chain of command. In the Office of the Secretary of Defense or in a Service Secretariat, we may report to a Senior Executive Service civilian. On large joint and service staffs, this is usually the first tier who can approve wide circulation of a concept or approve critical comments on documents that we review from other organizations.[1]

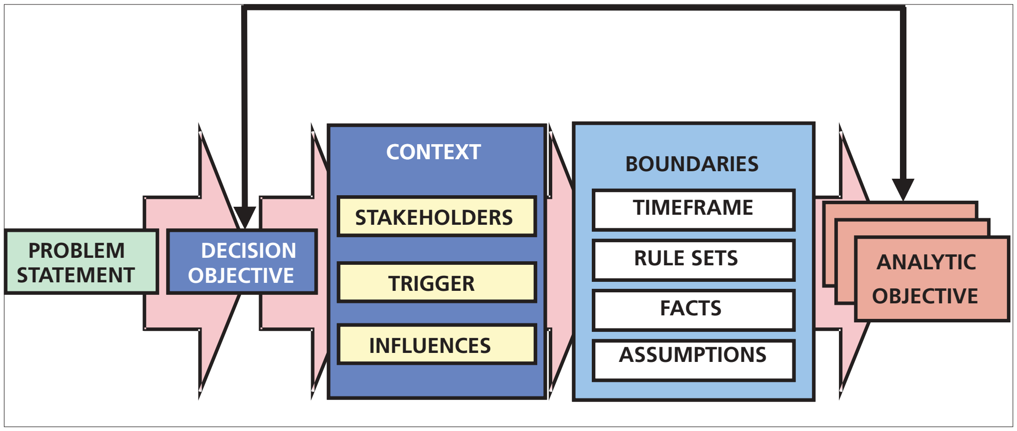


Figure 2–1. The Definition Phase.

The background and experience of the decision maker may influence how we make presentations, and apply the EDM framework. As their seniority increases, executive decision makers (including ourselves) are less likely to have detailed functional expertise or personal experience to apply to the issue. The decision maker may be a civilian appointee without prior military service. It is sometimes incumbent upon us to educate the decision maker as we describe the problem to ensure that we arrive at mutually understood terms.

As you will see, we highly recommend involving the decision maker at several points in the Definition Phase. In some cases, he or she may provide us with elements of the framework directly, such as the problem statement or the decision objective. In other circumstances, we may want the decision maker to approve our proposals to ensure that we address the issue in terms meaningful to him or her, and therefore to our organization, before we invest significant time and energy executing the remainder of the framework.

Defining the Problem

In general terms, a problem exists when there is a situation that presents doubt, perplexity, or difficulty; or when a question is offered for consideration, discussion, or solution. In the Department of Defense, we have a problem whenever we have a requirement or expectation that is not being or will not be met, whether due to inadequate equipment, organization, doctrine, training or policy. Our recognition that a problem exists is the first step in describing it in meaningful terms. Facile as it may seem, we must ask ourselves whether we really do have a problem. Is there something that we need to fix?

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[1] Critical comments, in the lexicon of joint staff work, mean that the organization disagrees with a product as written and will object to its continued progress in staffing. The owning office can either modify the product or forward it with the critical comments, realizing that the opposing organization may continue its objections as far as a mutual superior.

As we define the problem, we must determine our expectation or requirement and compare it to our existing and predicted conditions. The difference between what we have and what we need is the magnitude of the problem. The effect of failing to solve it is the problem's importance, which is a value judgment. How quickly this problem needs to be solved is its urgency. Identifying the *magnitude*, the *importance*, and the *urgency* of the problem leads us to decide how many intellectual, physical, and fiscal resources our organization should devote to solving it and how quickly they need to be applied.

ORGANIZING THE PROBLEM

There are two aspects of organizing the problem that are important to us at the beginning of the Definition Phase. The first is whether and how the problem we are solving fits into a larger picture and then how much of that larger picture we have to consider as we proceed. The second is how we want to organize the problem for ourselves and our staff, i.e., whether we want to break our problem into smaller pieces that allow different people to work more or less independently on each.

First, we consider the external aspect; we need to understand the nature of the problem and its backdrop. The simplest case is a stand-alone problem that can or must be considered in isolation. Some complex problems cannot be segmented into smaller pieces or solved with a series of decisions and they do not permit graduated kinds of alternatives. Issues such as whether the United States should retain its unique Marine Corps or whether gays should serve openly in the military cannot be reduced further. This is most often the case with values-associated decisions. While these problems' solutions may involve simple binary choices, the ramifications of a decision may be quite complex.

In DoD, self-contained problems are few and far between for any but trivial problems. In fact, there is a long historical and contemporary list of problems that DoD has treated as if they were isolated problems when they were not, e.g., ship design decisions that affect maintenance activities and training commands; reduced spare parts funding that adversely affects retention and therefore increases recruiting goals. In most cases we will not expand our problem to include these second-order effects, but we need to be aware of them as we proceed. The mapping techniques we are about to discuss can help us clarify the relationship of our problem to other problems.

Second, after considering its external connections, we can use the same mapping techniques to organize our problem internally for the analysis phase, i.e., to decide whether it has more than one moving part and if so how they are connected. Usually, defense problems are complex and multi-faceted. To reduce their complexity, we can organize them into constituent sets of smaller problems in one of three ways: by hierarchy, by linkages, or by sequence.

Hierarchical Problem Structure

To organize a problem hierarchically, we identify the problem at its broadest level and descend into greater level of detail. For example, the U.S. Army conducts a biennial Total Army Analysis to identify its optimal force structure and therefore its end strength or man-power levels. In doing so, the Army categorizes forces in several ways: (1) by the status and availability of soldiers, i.e., whether they are in the Active Component or Reserve Component (the Army Reserve and National Guard); (2) by their purpose as combat, combat support, or combat service support units; and (3) by their missions and likely employment. Different organizations within the

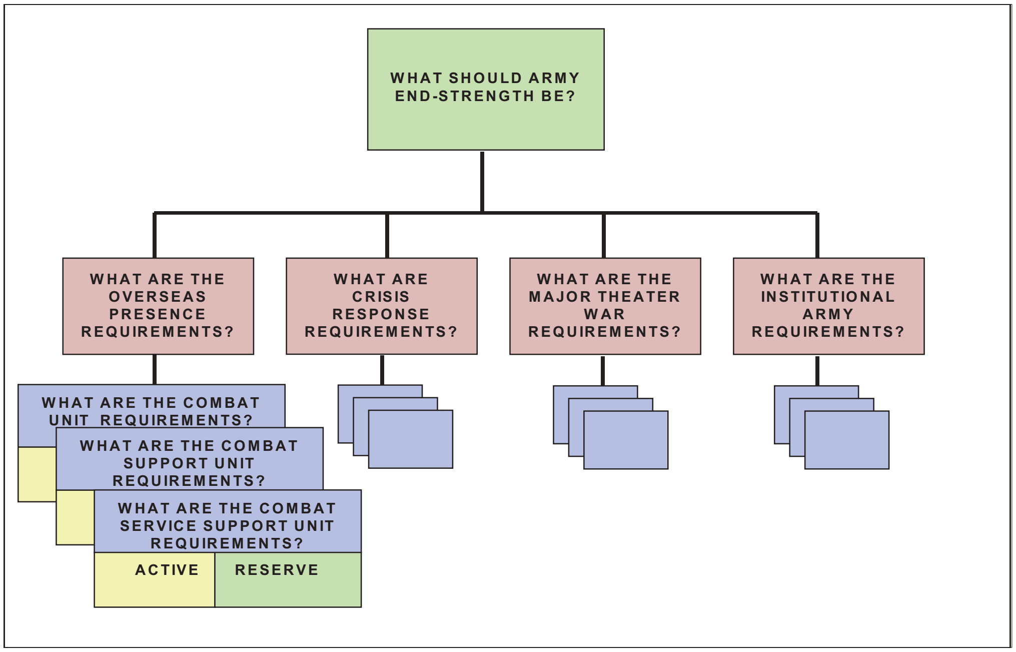
WHAT SHOULD ARMY END-STRENGTH BE?
WHAT ARE THE OVERSEAS PRESENCE REQUIREMENTS?
WHAT ARE CRISIS RESPONSE REQUIREMENTS?
WHAT ARE THE MAJOR THEATER WAR REQUIREMENTS?
WHAT ARE THE INSTITUTIONAL ARMY REQUIREMENTS?
WHAT ARE THE COMBAT UNIT REQUIREMENTS?
WHAT ARE THE COMBAT SUPPORT UNIT REQUIREMENTS?
WHAT ARE THE COMBAT SERVICE SUPPORT UNIT REQUIREMENTS?
ACTIVE
RESERVE

Figure 2–2. Hierarchal Problem Organization

Army emphasize different categories in their planning and there are many claimants for similar units. Army Headquarters determines Army end strength by breaking the problem into components to facilitate its examination and solution.

Figure 2-2 shows one way that Army Headquarters might organize this problem to identify its force structure requirements. They could break it into solvable pieces by sorting force structure requirements first by mission, then by the type of units required, and then by how quickly they are required. After they identify the ideal requirements for each piece, the planners can combine the force requirements to decide where to accept overlaps and gaps. Often, in a situation such as this, the higher headquarters tasks another organization to solve a part of the problem independently. During the Total Army Analysis, Army planners rely heavily on the warfighting commanders of the Central and Pacific Commands to identify forces and their required delivery dates for the major theater wars.

With complex problems that we can arrange into a hierarchy, naturally we would like to start with the broadest problem and then solve its descendents. The inherent danger in this, however, is the sub-optimization that occurs when the broad problem cannot be solved before the descendents. When we recombine the solutions, the compromises necessary to build a composite alternative tend to move away from the optimal solutions of the individual sub-problems. Some participants may resist that movement.

Linked Problem Structure

A set of linked problems requires inter-related decisions because the solution to one problem affects the solution of others. If we decide to shift a particular maintenance mission to a reserve component to solve an active component manpower shortfall, then we may exacerbate a readiness problem and increase the recruiting and training challenges with which the reserves are already struggling. Diagrams of linked problems resemble networks.

Often we must consider the solutions to linked problems simultaneously, as shown in figure 2-3, which features design decisions related to a tactical aircraft. For example, aircraft weight is influenced by the choice of engine (its physical characteristics and fuel consumption, etc.), ordnance delivery requirements and, in turn, aircraft weight will affect speed and range. If we decide not to solve linked problems simultaneously, we usually address the spillover effects of our decision while building alternatives in the Analysis Phase or during the Reconciliation Phase of our decision-making framework.

Sequential Problem Structure

Sequential problems depend on the outcome of a preceding decision to frame and reduce uncertainty about the next problem. Often we can take an incremental approach toward a complex problem by making a policy adjustment or funding research, evaluating the results, and then proceeding if the effort is worthwhile. This is the essential philosophy of John Boyd's popular Observe-Orient-Decide-Act loop and the concept behind branches and sequels in military operational planning.

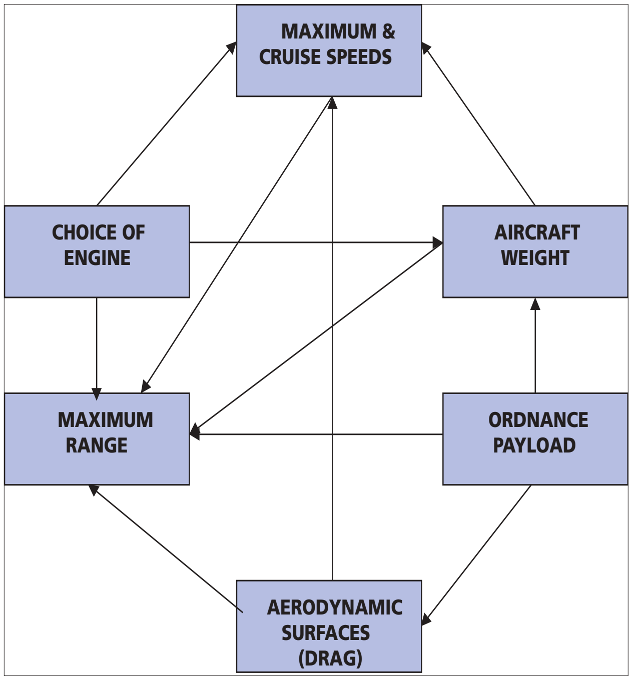
MAXIMUM & CRUISE SPEEDS
CHOICE OF ENGINE
AIRCRAFT WEIGHT
MAXIMUM RANGE
ORDNANCE PAYLOAD
AERODYNAMIC SURFACES (DRAG)

Figure 2-3.Linked Problem Organization

The Defense Acquisition System (DAS), shown in figure 2-4, is a series of sequential decisions (milestones), each of which depends upon the outcome of work that is approved in the preceding milestone. The Department of Defense begins large weapons programs by identifying a need or requirement in general terms and approving its formal exploration at a formal decision hearing or milestone. After refining concept studies and making technology choices, the program reaches another milestone decision and DoD must formally approve its progression. The program will face more reviews and another milestone before it goes into production; each decision point is an opportunity for adjustment or cancellation.

Sequential decision making is a conservative approach that minimizes risk, allows some present uncertainties to be resolved before the next decision, and supports consensus building because the changes from the status quo are neither dramatic nor very threatening. For example, the military is currently running several pilot programs in which private contractors build or manage the family housing on or near a base. DoD's eventual goal is to privatize large amounts of its housing and thereby eliminate the enormous maintenance and repair backlog of government-owned housing. How quickly DoD moves toward privatization, and the form it takes, depends upon the success of the pilot programs. There will be a series of sequential decisions about how to improve contractor performance, by how much, and when to transfer additional military family housing to contractors.

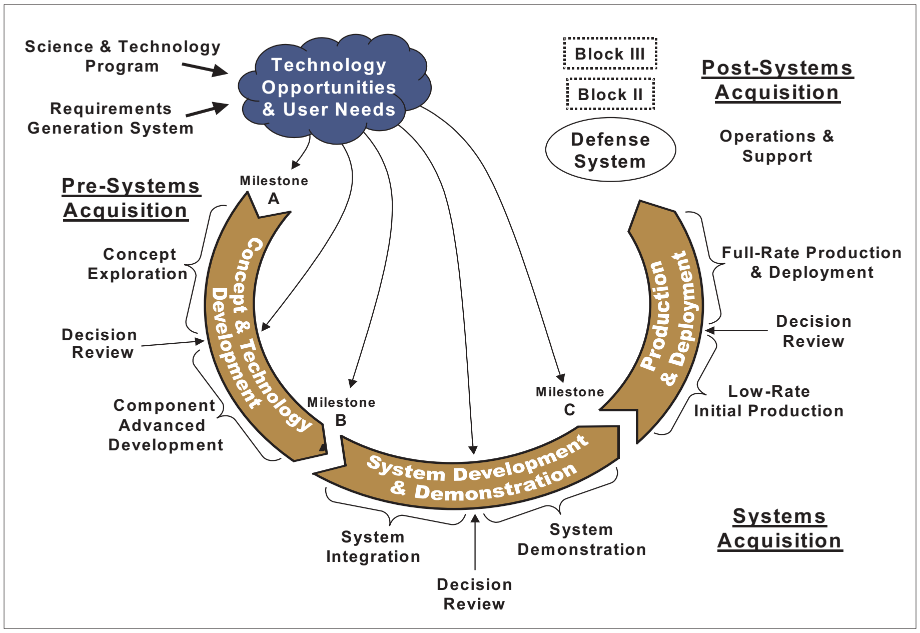
Science & Technology Program
Requirements Generation System
Technology Opportunities & User Needs
Block III
Block II
Defense System
Post-Systems Acquisition
Operations & Support
Pre-Systems Acquisition
Milestone A
Concept Exploration
Concept & Technology Development
Decision Review
Component Advanced Development
Milestone B
Milestone C
System Development & Demonstration
Production & Deployment
Full-Rate Production & Deployment
Decision Review
Low-Rate Initial Production
System Integration
System Demonstration
Decision Review
Systems Acquisition

Figure 2–4. Sequential Problem Organization

After we understand the backdrop to our problem, we decide which part of the overall problem we are going to solve immediately. The granularity of the problem and the seniority of our decision maker are related to the level of detail at which we will solve it. Broad issues suggest broad solutions. For instance, the Secretary of Defense should not decide how many bombs the Joint Strike Fighter needs to carry. Senior leaders should provide overall general guidance and leave it to their subordinates to work through the more detailed levels. During World War II, General Patton prohibited his subordinates from displaying units on their maps more than two levels below their level of command to prevent them from micro-managing and to keep them focused at the appropriate level of operations.

Organizing the problem and deciding at which level of detail we want to address it also impacts our planning horizon for this decision—are we going to solve this problem sweepingly or begin to chip away at it sequentially? Do we want a comprehensive alternative or a quick fix? Naturally, just as more general problems tend to require grander solutions, those solutions are likely to require execution over a longer term. If we choose to present the problem as part of a hierarchy, we expect that the further we descend the more detailed and short-term our problem statements become. Likewise, as we present solutions, we may brief in terms of generalities. Often those generalities are based upon detailed, rigorous problem solving whose intricacies do not interest the decision maker—he or she cares only that they were done and done well.

PROBLEM STATEMENT

We express the results of this process of problem organization as a Problem Statement. The decision maker should approve the problem statement because the single most likely reason for poor decision making is misformulating the problem. Consider the example problem statements below:

- The U.S. Navy needs an operational carrier-based deep strike capability by 2015.
- DoD needs a process to reduce its base infrastructure by 15 percent in the next ten years and it needs a process to identify candidate facilities for closure.
- Some parts of society perceive that the military's gender-integrated basic training is inefficient and encourages sexual harassment.

We said that the problem statement should encompass the appropriate level of detail for the organization that is trying to solve the problem. The first example above is too general to permit us to choose among specific munitions, but it could set the stage for concept development projects by space, aircraft, and missile system manufacturers. The manner in which we express the problem statement is also important. In the second example above, we expect to be asked, "15 percent of what - operating costs, number of facilities, acreage...? Why 15 percent?" If we know what we want and why, we can build this knowledge into the problem statement or answer these types of questions with confidence; if not, we need to better define the problem. In the last example above, we have an instance in which we may not think there is a problem, but someone else does, and we may be tasked to determine whether a problem exists, or even to "prove" a negative, the absence of a problem.

Decision Objectives

Our decision objective is the desired outcome of our organization's decision making. It is analogous to a mission statement.[2] We derive our decision objective from our problem statement. The decision objective is our goal; it provides clarity as we explain our decision process to others

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[2] If we have arranged the problem into several hierarchical, linked or phased decisions, we may have more than one decision objective within the context of the overall problem. We will consider each of those decision objectives in isolation, however, and for simplicity we will refer to a single decision objective throughout the remainder of the text.

and provides direction for accumulating important information about the problem. Decision objectives should be crafted in terms of solving the problem we identified in the problem statement, and they should not be constrained by the information currently available about the problem. There is a one-to-one correspondence between the problem statement and the decision objective; if we break a complex problem into segments, we create a decision objective for each segment of the problem.

The decision objective is a vital point of reference, therefore we state it simply and clearly, and get it approved by the decision maker. Here are two examples of decision objectives:

- Identify a replacement weapon system for the F-117 Stealth Fighter.
- Determine the least costly method to provide Military Family Housing in the continental United States that equals or exceeds present quality standards.

Each of these decision objectives clearly expresses the expectations of the decision maker. In the first case, there is less specificity in the guidance; the staff may look at current aircraft programs, aircraft under development, new concepts, or non-aircraft alternatives. The verbiage deliberately allows for all those possibilities. If the decision maker wanted us to consider only aircraft alternatives, he or she would specify "aircraft" versus "weapon system" after "replacement." If we are not sure, we should ask. The second decision objective is more specific, requiring us to include cost and quality in our decision—consider how much more difficult it would be to find the "best" way to provide Military Family Housing.

Problem Context

Force planning and policy problems seldom exist in isolation and their circumstances vary in urgency, magnitude, and importance. We regard a procurement cost overrun as a lesser problem for a weapon system being used in combat now than we would while procuring the same weapon in peacetime. As we examine the problem context, we categorize the factors surrounding the decision (in our vocabulary for this course) as Stakeholders, Triggers, and Influences. The stakeholders are those who participate in the decision or are affected by the results of the decision. The trigger is the event that necessitates a decision and determines how quickly a decision is needed. Influences are all the other aspects of the problem that matter and those we will consider in the remainder of the framework.

If we overlook significant factors as we study the context of a problem, we may oversimplify and thereby degrade the quality of the Definition Phase and ultimately the decision itself. If we include too many factors, we create needless complexity and waste resources making our decision. Clearly, after considering the problem's magnitude, importance, and urgency, we must strike a balance between the time available for those involved in the decision to consider a multitude of complex factors and our desire for completeness in describing the problem. Deciding which factors we will consider affects the way we will execute the Analysis Phase, especially the levels of abstraction and simplification we accept in our models.

Because we want a comprehensive list of factors affecting our problem, brainstorming is an excellent technique for identifying stakeholders, triggers, and influences. After we are satisfied with our lists of factors, we can label them as internal or external to the decision. The factors we are going to consider within our organization as we make this decision are internal; the external factors are those outside our organization that we will reconcile later or not at all. Later in the

Definition Phase, we will winnow these factors to bound our problem and simplify our analysis. As we identify stakeholders, triggers, and influences, we may list some factors twice or they may overlap with one another while we describe the problem context. In this portion of the Definition Phase, we concentrate on listing every important factor; precise labeling is truly of secondary importance.

STAKEHOLDERS

In DoD, there are usually a variety of organizations and individuals that are affected by our decisions and, logically, each wants to affect our decision making. In our framework, we refer to any individual or group that has an interest in the outcome of a decision as a stakeholder. Some stakeholders influence us or participate as we make our organization's decision; they are internal stakeholders. Others are external; they may participate later during the Reconciliation Phase or not at all.

Particularly in the Department of Defense, the stakeholders most affected by the results may not participate in the decision making, e.g., changes in pay and housing allowances affect all service members, but very few participate in decisions to adjust them. As we list stakeholders while examining the problem context, we should also list each stakeholder's interest or concern. We want to see whether there are concerns we need to incorporate into our decision, and therefore into the Analysis Phase. We also desire to know how well the other stakeholder's interests align with ours; this will be very important during the Reconciliation Phase. Each stakeholder has its own perspective, offers unique opportunities, and presents certain obstacles toward solving a problem.

TRIGGERS

Each problem that requires a decision bubbles to the surface because of some underlying force, for good or ill. Understanding what compels a solution now, in the near term, or later is an important part of the sorting process used by senior leaders. The trigger is usually what determines the urgency of a decision. Some triggers are highly visible and call immediate attention to a problem, some triggers arise from regularly scheduled events, and others result from good planning. A series of sexual harassment incidents requires some immediate, visible corrective action such as forming an investigatory committee and initiating a policy review. The President's budget must be submitted every year in February and from that deadline DoD reverse engineers its formal resource allocation process with its myriad of decisions.

Triggers, too, may be internal or external; a public outcry is an external trigger while organizations with sound strategic planning impose their own reviews to create internal triggers that lead to important decisions. We identify the trigger so that the decision maker and we become clear on why we are addressing this problem now and to agree on which stakeholders' satisfaction matters most.

INFLUENCES

We define influences as factors we know at the beginning of the problem that affect our decision maker's selection of a procurement or policy option. Influences are background information we are going to consider while making this decision. Internal influences are the concerns we are going to address now while solving the problem within our organization; they are not necessarily under our organization's control, but we are going to factor them into our decision. They will affect our activity in the Analysis Phase. We set aside external influences while making our organization's decision, realizing that we may very well address them during the Reconciliation Phase as we build a consensus on accepting our chosen alternative. Designating an influence as external does not mean we discount it. External influences are germane to the problem and may later come to dominate our senior leaders' choice of which alternative we implement.

Deciding which influences are internal often depends on where our organization sits in the chain of command. Influences that we consider external may be internal to the next decision maker. For example, as the Deputy Secretary of Defense considers the requirement to modernize U.S. tactical aviation for the 21st Century, the historical and projected aviation procurement budgets of the Departments of the Navy and Air Force are internal influences. He needs to consider their historical and projected budgets to assess whether current aviation programs are affordable and to create alternatives if they are not. An external influence for the Deputy Secretary is where the new aircraft may be manufactured—within DoD, this is not of immediate importance to us. Later, during the reconciliation of DoD's proposal with Congress in the federal budget process, the Deputy Secretary will unavoidably address the manufacturers' locations. For our organization (DoD), the manufacturing location is a major external influence, while to Congress it is an internal influence whose importance varies among individual members of Congress.

INFLUENCE DIAGRAMS

A common mechanism for displaying the problem context is the influence diagram. An influence diagram is made up of three principal nodes: decisions (rectangular); random, unknowable, or uncontrollable factors (oval); and evaluations, constants, or calculations (rectangular with rounded corners). We connect the nodes with arrows that indicate how one node influences another. Figure 2-5 is an influence diagram for selecting among shallow water mine detection systems. Performance, cost, and schedule each contribute to the overall value of each prototype. Presently, we do not know the exact characteristics of the mines we may need to detect in the future, which means that our performance evaluation will be based on imperfect information.

While it resembles a flowchart, the influence diagram has several important distinctions. An influence diagram is a snapshot in time, the time of this decision, and therefore it cannot incorporate feedback. Influence diagrams reflect a specific situation, not a process. Also, because they are simplifications, they do not display nuances or important details. They are helpful for diagramming complex decisions and establishing a framework for discus-

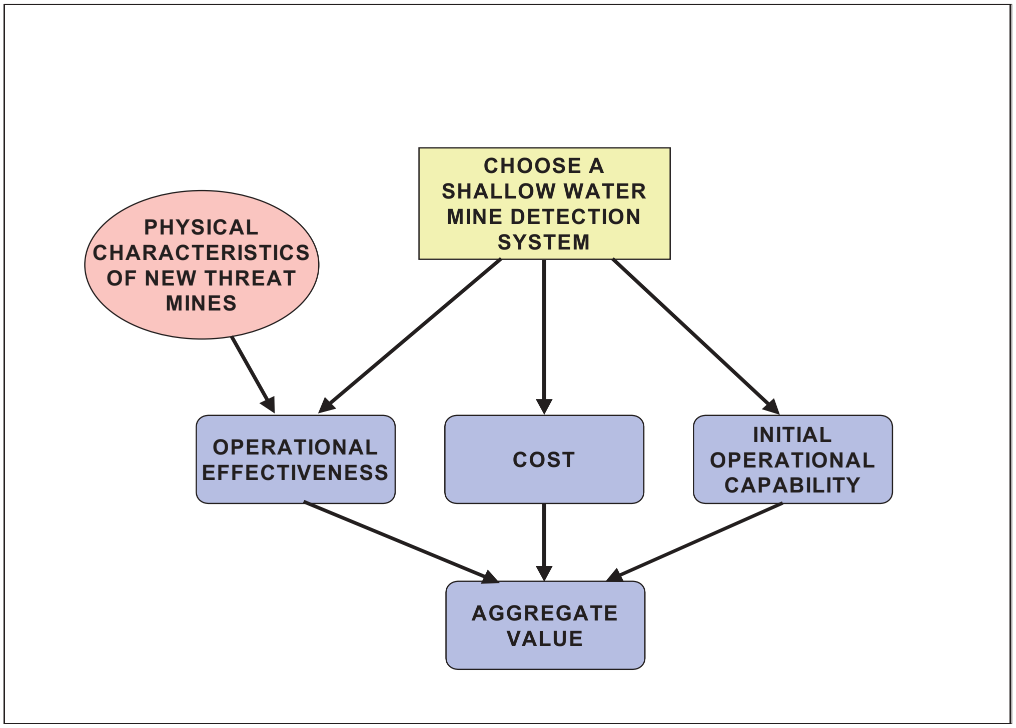
PHYSICAL CHARACTERISTICS OF NEW THREAT MINES
CHOOSE A SHALLOW WATER MINE DETECTION SYSTEM
OPERATIONAL EFFECTIVENESS
COST
INITIAL OPERATIONAL CAPABILITY
AGGREGATE VALUE

Figure 2–5. Influence Diagram.

sion about context. By building and displaying an influence diagram, participants in a decision create a larger common knowledge basis for the rest of the Definition Phase.

POLITICAL INFLUENCES AND COMPROMISE

We know that the decision maker's background and current position are part of the context of force planning decisions. This is natural in an environment that promotes advocacy and competition between ideas. We also know that what is rational from one perspective may not be so clear from another. Electing to retain a less costly military base in South Carolina and close a similar base in California appears obvious and logical, until we recall that California has already experienced a 50 percent reduction in its DoD facilities during past base closure rounds. Also, many California legislators who will vote on the defense budget were elected (in part) by promising no further base reductions in their state. We may assume that both states' congressional delegations are stakeholders in this decision and that someone is going to be unhappy with the outcome. The politics of the situation may reverse our organization's internally logical decision and recommendation to close the base in California.

We believe, fundamentally, that there is a best policy or procurement alternative for each national security problem that we can and should identify without being influenced by politics. Once we identify our preferred solution, it becomes the "right" thing for our organization to advocate. We need to know what this solution is before we start to reconcile differences with other stakeholders; compromise is often necessary, but we should always know when and what we are compromising, and how far we have moved away from the optimal choice.

Advocacy is an important aspect of American government and is integral to the diffusion of power by checks and balances. The compromises we make, or are imposed upon us, are required by the politics of the situation and are not necessarily shameful. Each compromise should, however, be recognizable by our organization and not be a blind retreat. By knowing our organization's optimal alternative, we may be able to move closer to that alternative later in the process as circumstances change, making some of our retreats temporary rather than permanent. We must also emphasize that people who disagree with our choice are not necessarily wrong or venal. From their perspective as advocates of other organizations, their positions may make perfect sense. The Congressional delegation from California was elected to represent the interests of Californians, which includes jobs and national security. The higher cost to DoD of the California base contrasts with the cost of losing the base to the California delegation; both interests are logical from the perspective of each group.

Politics (in this framework) is generally an external influence in our organization's decision making. One of the reasons we look at external influences during the Definition Phase is to help us prepare for the Reconciliation Phase. We must be able to explain our decision to other stakeholders, some of whom will not like our choice. These preparations may require that we do some additional analysis that may not be necessary for our internal decision, but will help us address the questions we anticipate, the concerns, and the interests of others. In summary, we recognize that we often make defense decisions in a highly charged political environment. We advocate making a rational decision optimized from our organization's perspective and then embracing the political factors to achieve acceptance, and compromise where necessary.

WORKING GROUPS: STAKEHOLDERS AND INFLUENCES

In complex situations that have many variables and components, we may require a multi-disciplinary group effort to define the problem. This is often DoD's impetus for creating organizations, such as the Joint Requirements Oversight Council's Joint Warfare Capabilities Assessment teams that have members from the Joint Staff (often multiple directorates), the services, the unified commands, and defense agencies. Every organization with an important stake in an issue has the opportunity to raise its concerns and announce its preferences with the others in attendance. Representatives are there to contribute and collect ideas and provide early warning—to their own organizations and to others—when an issue or an alternative is controversial. To describe a complex defense problem, even within our own organization, we combine professional military viewpoints to ensure that we develop a thorough, balanced perspective. Our team may be composed of operators and functional area experts, e.g., logisticians, historians, analysts.

Staff processes often take advantage of working groups. Most of the members, and their organizations, are stakeholders by definition. The personality, experience, and background of their members heavily influence the products of working groups. Each participant has the opportunity to affect the group's position on issues, either to promote an agenda, to protect an interest, or to objectively discern what is best for the larger command as a whole. The discussion within a working group and its deliberations may be internal influences on our organization's decision making, or we may treat them as external influences that provide us with insights for reconciliation by indicating who will support or oppose our alternative.

Problem Boundaries

In addition to actually defining the problem, we use the Definition Phase to bound the problem by identifying constraints and limiting the influences we will consider when making this decision. The problem and the decision objective exist within the overall context that we have already categorized and described in some detail. But a decision maker never has unlimited time, personnel, or funding to apply to any problem. To accommodate these restrictions, we limit the scope of the upcoming Analysis Phase by establishing boundaries. We identify boundaries carefully; a poor choice may inadvertently forestall complete analysis, limit the range of alternatives, pre-select one alternative, or introduce bias into the decision. A good choice enables the analysts to efficiently support the decision. We divide boundaries into four categories: Timeframes, Rule Sets, Facts, and Assumptions. We will draw many of our boundaries from our earlier analysis of the problem context, particularly the internal influences.

TIMEFRAME

We have timeframe boundaries of two kinds: deadlines (how long do we have to make this decision?) and planning horizons (how long will we need to implement our solution and how long it will be in effect?) As we identify timeframe boundaries, we return to the problem context, especially our knowledge of what triggered this decision. Importantly, how much time do we have for analysis before we need a decision? One of the criticisms of the Quadrennial Defense Review mandated by Congress is that its deadline of September 1st falls soon after the new administration takes office. Congress should not expect highly detailed force structure decisions because there is simply not enough time to do the analysis and evaluation necessary to inform executive decision makers as they select the particulars of their defense strategy.

The planning horizon is another important boundary. Do we need a short-term solution or a set of alternatives that will solve this problem permanently? Shorter timeframes limit our alternatives to those that show immediate results and therefore favor improving existing systems versus new equipment or methodologies. Similarly, shorter planning horizons lead us toward conservative, incremental approaches. A fund surplus that must be obligated in this fiscal quarter should probably not be allocated to research and development. Long-term planning horizons permit more innovative solutions. Thus, selecting the planning horizon boundary will have an important effect later on how we shape alternatives and how we decide to calculate cost.

RULE SETS

Superiors in our chain of command and organizational culture may establish boundaries that channel our range of alternatives. Also known as value networks, the nature and assumptions behind our present force structure, and its success, have inertia of their own. On the positive side, preserving service culture protects the lessons our predecessors have paid for in blood and treasure. On its negative side, military conservatism or parochialism denies the fruits of technology and growth to those who must execute the next missions. We do not wish to change a service role or culture lightly, therefore one of the primary things critical thinking can help us achieve is to discriminate between truly promising alternatives and those that are merely different.

Closely related to service cultures and roles are the business distinctions between sustaining innovations (existing product improvement) and disruptive technologies (new ways of doing things). The military analogy is whether to execute our current doctrine more efficiently or to adopt new operational concepts, often based on new technologies or systems that may not be mature. We need to know, as we frame our decision, whether our decision maker is willing to consider disruptive alternatives if these represent the optimal solution. We need to know when there are rules that constrain our decision making, either to abide by them or to challenge them.

FACTS

Facts, in our framework, are known truths or "givens" that are not debatable within our organization. Facts may be truths from the historical or physical realms, performance thresholds or objectives, cost limitations, timelines, or any precondition that affects the range of viable alternatives. For example, we may treat Key Performance Parameters for weapons systems as facts. An airplane must fly x distance and back or it is not an eligible alternative. Aircraft range bounds the selection of alternatives and is not negotiable below a certain level.

Givens are suppositions provided by a higher headquarters that we regard as unassailable, although they might not be proven, e.g., we require a force structure capable of executing two overlapping major theater wars. We derive many of our facts (and assumptions) from the lists of influences we made earlier describing the problem context. An example of an internal influence we may classify as a fact is a legal restriction that limits procurement alternatives to U.S. manufactured equipment. We document our facts to keep our decision structured and to display our thought process to the decision maker. If he or she disagrees with our selection, we prefer to adjust the list, before proceeding into the Analysis Phase.

ASSUMPTIONS

Assumptions are suppositions we make in order to proceed with decision making; others may challenge them within our organization and later during reconciliation. They are statements we take to be true without proof, and therefore we should limit them to the absolute minimum necessary to proceed into problem analysis.

Assumptions help us bound our problem and we often use them to place the alternatives on a level playing field to simplify comparisons. We may make an assumption about the projected rate of inflation for the next ten years when we tell contractors to provide us with total ownership costs for their proposals, or by fixing a student population to size training facilities. In defense planning, we make assumptions about enemy capabilities and when they will be operational. The number of assumptions we find acceptable in a problem definition is a function of the problem's importance, magnitude, and urgency.

Poor or hidden assumptions may create fatal flaws in the quality of analysis that affect the decision. One of the reasons many defense experts received Defense Secretary Aspin's 1992 Bottom-Up Review coldly was its easily questioned assumptions, e.g., any and all lesser conflicts could be executed by the two major theater war force structure.

When an assumption is necessary to proceed, but we cannot be certain of or agree to its assigned value, we may specify that analysts use a process called sensitivity analysis. With sensitivity analysis, we explore changes to the assumption—such as the use of weapons of mass destruction by an enemy force—and assess the effect of the changes on the outcome of our decision (see Chapter 7 for more detail). By minimizing assumptions and using sensitivity analysis, we seek to diffuse controversy about the problem definition and decision process and direct the debate toward outcomes and choices.

As with facts, we document our assumptions and have the decision maker approve them. Because assumptions are more subjective than facts, the decision maker's approval is more important for assumptions. If he or she disagrees with them, we must modify them now, before we begin the Analysis Phase, or we may put the entire decision at risk. Our assumptions should appear early in the reports that record our decision making. We, with our analysts, will probably have to make additional assumptions during the Analysis Phase.

Analytic Objectives

Most defense decisions require supporting analysis to ensure that we choose rationally; the analytic objectives are our bridge from the Definition Phase to the Analysis Phase. Analytic objectives are influenced by the problem context and the problem boundaries and may be derived from them directly. The analytic objectives must clearly support the decision objective. If the problem context and boundaries lead to analytic objectives that seem disconnected from the decision objective, something is wrong; we need to review the latter or reexamine the context and boundaries.

Organizations in DoD often contract professional analysts for decision support analysis. These analysts have varied backgrounds that may or may not include military experience. Defining the objectives for our analyses requires a large injection of informed military judgment, i.e., we dare not leave the analysts to their own devices.

In our framework, we always have at least one analytic objective that is subordinate to the decision objective. In even the simplest of cases, we separate the analytic objective from the decision objective because *analysis alone does not decide the issue for us;* it is a tool that we couple with professional judgment to achieve the decision objective. With increasingly complex decisions, we often have multiple supporting analytic objectives. When there is only one analytic objective, its phrasing may be similar to that of the decision objective; however, because analytic objectives describe the goals of the supporting analysis, they often begin with words like "compare" or "evaluate."

Our analytic objectives must lend themselves to independent study; the analyst, with our help, must be able to isolate this subject for study. For example, if our decision objective is to select a new medium-weight truck for the Army, our supporting analytic objective might be: Compare the manufacturers' proposals on the basis of cost and effectiveness for medium-weight truck fleets of 5,000, 10,000, and 20,000 vehicles.

Similarly, each supporting research effort or study should have its own analytic objective. We may arrange related analytic objectives hierarchically or sequentially to indicate when one analysis must precede another. In the case of the Military Family Housing decision objective we used earlier, we may establish the following analytic objectives:

- Compare the cost and effectiveness of government-owned and managed housing, privatized housing, and housing on the civilian economy for military families on bases, stations, or posts within a one hour commuting time of a city of 500,000.
- Identify candidate bases, stations, and posts for pilot program conversions to develop more cost-effective Military Family Housing programs.

Our first analytic objective must be completed before we can proceed to the second. Both analytic objectives suggest that we may require subordinate analyses, i.e., we know it is not practical to do a 100 percent survey of all housing sites; therefore, our first sub-objective under the first analytic objective is to "Build a Data Base of Housing Areas" based on location criteria. We link the objectives of each supporting analysis in the hierarchy to an analytic objective that supports the decision objective that we tied directly to the problem.

Summary

The Definition Phase is extremely important because without appropriate guidance and structure, we can spend large amounts of time diligently solving the wrong problems. Active participation in the Definition Phase gives the decision maker considerable influence over the future course of analysis. The Definition Phase therefore involves much more than just identifying a problem or saying we are going to make a choice among alternatives.

At the beginning of the phase, we craft a problem statement, organize the problem, and specify our decision objective. We identify the context surrounding the problem in terms of stakeholders, triggers, and influences, usually by brainstorming to capture every nuance of the problem. Together, these factors provide important background information that helps us further frame the problem. Next, we establish problem boundaries that will refine our effort, mindful that the timeframe, rule sets, facts, and assumptions set the stage for the forthcoming analysis. Finally, we select analytic objectives. Subordinate to the decision objective, they focus our efforts and limit our scope during the Analysis Phase. We involve the decision maker throughout the Definition Phase to ensure that we are solving the problem he or she wants solved before we begin the much more costly Analysis Phase.

CASE STUDY: THE DEFINITION PHASE
USMC MEDIUM-LIFT REQUIREMENTS: THE V-22 OSPREY AND HELICOPTERS

Background. Shortly after World War II, the U.S. Marine Corps became interested in using nascent tilt-rotor technology for troop-carrying aircraft in vertical assaults. A tilt-rotor air-craft takes off and lands like a helicopter but tilts the rotors on its wing tips forward to achieve much faster forward flight than a helicopter. By 1980 Marine Corps doctrine specified one third of an amphibious assault force would land by helicopter beyond the beach in the Amphibious Operations Area and that helicopters would deliver many of the supplies from ship to shore needed by the assault force. Senior defense leaders also knew that the medium-lift helicopter that fulfilled this role, the CH-46, had to be replaced by the end of the decade.

In 1981 DoD created a Joint Tilt-Rotor Program to explore using tilt-rotor aircraft for medium lift and designated the Army as the lead agency with the Marines, Navy, and Air Force all participating. DoD projected it would purchase 913 aircraft. By 1988, however, the Army had withdrawn from the program, the Marines had taken the lead, and the Air Force had reduced its buy for a new projected DoD total of 657 aircraft.

By the end of the 1980's, Marine Corps doctrine embraced over-the-horizon amphibious assaults to reduce the vulnerability of ships off-loading onto a beachhead within sight of the coast. Over-the-horizon assaults required three new weapons systems: the Landing Craft Air Cushioned (hovercraft) that could lift heavy but non-assault loads quickly from ship to shore; an Advanced Amphibious Assault Vehicle for forced-entry surface assault and protected mobility ashore;[3] and higher-speed, longer-ranging, medium airlift for the vertical assault element. This trio of new equipment would allow the Marines to depart further from seaward and to range deeper into the Amphibious Operations Area. The V-22, Bell-Boeing's tilt-rotor, 100 knots faster than comparable helicopters, was the Marines' preferred medium-lift platform.

The Marines believed that the speed and range advantages of the V-22 were so important that they crafted the Joint Service Operational Requirement (the equivalent of the current Operational Requirements Document) to mandate transit speeds of 250-275 knots, speeds that only the V-22 could meet. The V-22 was, however, much more costly than the helicopter alternatives. The medium-lift helicopter fleets, upgraded to V-22 avionics and electronics standards, cost roughly $46M (FY88 constant dollars) each, while the V-22 cost $67M.[4] Within DoD, a controversy arose whether the additional capability of the V-22—unquestioned by all—was worth the cost. In 1989, Secretary of Defense Cheney canceled the V-22 Program, citing near-term costs as one of the most compelling reasons, and he proposed meeting Marine Corps medium-lift requirements with a mix of CH-60 and CH-53E helicopters.

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[3] The AAAV passed Acqusition Milestone I began Program Definition and Risk Reduction in 1996. Prototype testing began in 2000 and the Marines expect the AAAV to achieve Initial Operational Capability in 2006.

[4] Derived from Simmons, L.D. et al, *Assessment of Alternatives for the V-22 Assault Aircraft Program,* Executive Overview, Institute for Defense Analysis, 1991, pp. 11-12.

Several congressional committees were unhappy with Secretary Cheney's decision. In the 1991 defense authorization and appropriations bills, the House and the Senate directed DoD to commission an independent Cost and Operational Effectiveness Analysis of the helicopter and V-22 alternatives. They specified five helicopter options[5] and six missions[6] and, in addition, told DoD to consider the vulnerability and likely combat attrition of each aircraft option. DoD commissioned the Institute for Defense Analysis (IDA), a Federally-Funded Research and Development Center, to conduct the Congressionally-directed study.

With this background, we will use the IDA Medium-Lift Study as a running example throughout the text to apply our Executive Decision-Making Framework as if we were on Secretary Cheney's staff in 1991. The complete five-volume Secret IDA Study, plus Executive Overview, is available in the Naval War College's classified library under call number U390 15 R-371 (S). Appendix 3 of this text contains the 19 July 1990 record of testimony before the Senate Appropriation Committee hearing on the V-22. It begins with a detailed overview of the study by its author, Dr. L. Dean Simmons, followed by a rebuttal by OSD, and some pointed questioning by several senators.

THE DEFINITION PHASE

Problem Statement. DoD, in particular the Marine Corps, needs a medium-lift aircraft to replace the aging CH-46 helicopter fleet.

Decision Objective. Identify the best alternative for meeting DoD's, particularly the Marines', medium-lift requirement.

Problem Context. Secretary of Defense Cheney canceled the V-22 program because he felt that DoD could acquire adequate medium-lift capability for the USMC amphibious assault mission at significantly lower cost by procuring a fleet of helicopters. He took this action on the advice of analysis done within the Office of the Secretary of Defense's Program Analysis and Evaluation Office (OSD/PA&E) then headed by Assistant Secretary of Defense David Chu. This action, Dr. Chu believed, would free much needed funds for other programs with a marginal loss of capabilities in Marine Corps medium-lift.

Others, including the Marine Corps, some members of Congress, and interested defense contractors, argued that Secretary of Defense Cheney and Dr. Chu were wrong and that the V-22 program should be continued. Congress continued to appropriate funds for the V-22. They directed, in the aforementioned bills, that DoD provide an independent study that compared the V-22 and a range of alternative aircraft packages in Marine Corps missions and a variety of other missions as well. All of the participants agreed that a decision was needed urgently to replace the aging medium-air fleet.

The biggest disagreement about the Marine medium-lift replacement aircraft was about magnitude: whether the much more expensive V-22 would provide a revolutionary capability required to execute over-the-horizon assaults or whether the V-22 was gold-plated medium-lift that helicopters could in fact achieve the mission, albeit less elegantly.

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[5] "... Including, but not limited to, CH-53E, BV-360, EH-101, CH-46E, CH-60 and any combination thereof....." *H.R. 2461*, Report 101-121, July 1, 1989.

[6] Amphibious ship-to-shore movement, follow-on operations, long-range Special Operations, Over-The-Horizon landings, drug interdiction, and Combat Search and Rescue. *H.R. 3072*, Report 101-345, November 13, 1989.

STAKEHOLDERS

Legislative Branch

- Congress as a whole is concerned about cost-effective national defense.
- Some Congressmen are concerned about V-22-related manufacturing jobs in their home states and districts.

Executive Branch

- Secretary of Defense Cheney (our decision maker) is concerned about the affordability of all DoD programs and their relative priority to one another.
- The Secretary of the Navy has conflicting interests; he wants to support the Marines yet he needs funding for four other Navy Department aircraft programs: the A-12 Avenger II medium strike aircraft, the new Maritime Patrol Aircraft, the SH-60 helicopter, and the F/A-18 Hornet strike fighter.
- The USMC Commandant is adamant; he wants this aircraft because it is essential to the Marine Corps' future operational concepts.
- The Chief of Naval Operations is concerned about protecting the aforementioned Navy aircraft programs although he would like to buy 50 V-22s for Combat Search and Rescue.
- Other service secretaries and service chiefs have limited interest in the V-22; the Air Force may make small quantity purchases for special operations missions, but it is not a high priority; the Army is indifferent and believes that too much money in general goes to support expensive aviation programs.

Contractors

- Bell/Boeing (now Textron) anticipates at least a $40B program from DoD, and with the research and development already paid for by DoD, a lucrative commercial opportunity to offer civilian tilt-rotors at competitive prices (compared to helicopters).
- Sikorsky and other helicopter manufacturers will gain an important contract if their air-frame is chosen to replace the CH-46.
- Japanese aircraft companies will develop tilt-rotor technology if Bell/Boeing does not; they are currently behind, but with no competition at all they could corner this market.

Labor Unions. The Texas and Pennsylvania factories would employ 2,000 people each through 2014 manufacturing the V-22. Altogether, according to the manufacturer, the V-22 program will sustain 15,000 jobs in 43 states. The United Auto Workers added V-22 funding as a "key vote" to its congressional scorecard, an important tool they use to distribute campaign funds to election candidates.

At this point, from IDA's point of view, all the stakeholders are external to the decision except the Secretary of Defense. They are doing the study for him and, while they will use data from other sources, like the Marine Corps, IDA will not allow them to participate directly in their analysis.

TRIGGER

The Marine's requirement for a wholesale replacement for the aging CH-46 medium-lift fleet is an internal trigger; the demands of Congress and the forthcoming DoD budget sub-missions (external triggers) mandate a decision as soon as possible.

INFLUENCES (E-EXTERNAL; I-INTERNAL)

- Aging CH-46 fleet; we need a decision soon. I
- Competition among major DoD programs for limited funding. I
- Six earlier studies supported V-22 procurement. E
- Amphibious assault medium-lift mission requirements dominate the other scenarios. I
- Marine Corps says V-22 is essential to Over-The-Horizon capability, predecessor to Operational Maneuver From The Sea (the current USMC operational concept). I
- Marine Corps scenarios require a medium-lift aircraft with a 200 NM tactical range. I
- DoD allocated $24B (FY88) for a replacement CH-60/CH-53E fleet. I
- The Marine Corps desires 425 V-22s to be able to lift 50% of the vertical assault force for the initial wave. I
- The Navy still has a requirement for 50 Combat Search and Rescue aircraft. I
- The Air Force still has a requirement for 50 Special Operations aircraft. I
- Distribution of V-22 jobs: 15,000 jobs in 43 states. E
- There is congressional pressure to reduce the defense budget and a presidential mandate to cut $6B from DoD's budget request. E
- V-22 leading-edge technology has vast commercial opportunities for U.S. aerospace industries. E
- Foreign competition: the Japanese were considering starting their own program that would compete in the civil aviation sector. E

BOUNDARIES

TIMEFRAME

The study had to be completed quickly before the next budget submission. Both the Marines and DoD sought a permanent and complete solution to medium-lift; therefore they were looking at a distant planning horizon. They framed the decision of which aircraft to purchase against a thirty-year timeframe, the expected time required to produce the aircraft fleet and its service life.

RULE SETS

The V-22 was in many ways a disruptive technology, but the Marine Corps had already embraced it. DoD had no objection to the technology itself. However, it was very concerned about cost and balancing the outlays for all of its programs in view of budget cuts. In this case, DoD leadership felt strongly that the much greater cost for introducing the new leap in technology that produced a marginal and unnecessary improvement in effectiveness—speed and range—was not justified. Congress, however, employed some additional rules, basically their constituents' issues in terms of jobs, which made the V-22 a very attractive option. The organizational culture of the Marine Corps, Department of Defense leadership, and Congress influenced their decisions regarding the worth of the V-22 compared to helicopters.

FACTS

- Congress specified scenarios for comparisons between the helicopters and the V-22; DoD could add more.
- The V-22 is 100 knots (nautical miles per hour) faster than helicopters.
- Survivability and attrition rates vary among the V-22 and the helicopters.
- Costs before 1990 cannot be recovered.
- DoD budgeted $24B (FY 88) for the Marine medium-lift replacement fleet.

ASSUMPTIONS

- Cold War era force-on-force models are adequate to evaluate assault scenarios (in 1990).
- Contractors' performance specifications and projections are accurate.
- All the helicopter alternatives require V-22 avionics to achieve the mission.
- DoD’s proposed replacement – a modified UH-60/CH-53E fleet – is the lowest cost, minimum effectiveness solution amongst the aircraft alternatives, i.e., there is no less expensive acceptable alternative.

Analytic Objective. Compare the V-22 and helicopter alternatives on the basis of cost and operational effectiveness.